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10-11-93  
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Grant No. NAG 2-438

Semi-Annual Status Report

March 1993 - August 1993

"Selection of Behavioral Tasks & Development of  
Software for Evaluation of Rhesus Monkey  
Behavior During Spaceflight"

Principal Investigator: Duane M. Rumbaugh  
Co-Investigator: David A. Washburn

Language Research Center

Georgia State University

University Plaza

Atlanta, GA 30303

(NASA-CR-194176) SELECTION OF  
BEHAVIORAL TASKS AND DEVELOPMENT OF  
SOFTWARE FOR EVALUATION OF RHESUS  
MONKEY BEHAVIOR DURING SPACEFLIGHT  
Semiannual Status Report, Mar. -  
Aug. 1993 (Georgia State Univ.)  
7 p

N94-13865

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G3/51 0186016

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Behavior & Performance Project

**I. SUMMARY OF FINDINGS:** The results of several experiments were disseminated professionally during this semiannual period. These peer-reviewed papers that were accepted for publication represent the growth of our research areas, as follow-up experiments to previously published work in cognition and enrichment have been completed and are being published. The presentations not only reflect the latest interesting results that we have obtained, but also serve as a testament to the intense interest that is being expressed for our test system and findings.

**A. Publications**

1. Washburn, D. A. (In press). The stimulus movement effect: Allocation of attention or artifact. Journal of Experimental Psychology: Animal Behavior Processes.

Abstract

In previous reports--including one by the present author--learning has been shown to benefit by having discriminanda move rather than remain stationary. This stimulus movement effect might be attributed to several theoretical mechanisms including attention, topological memory, and exposure duration. The present series of experiments was designed to contrast these potential explanatory factors. Ten rhesus monkeys were tested on a variety of computerized tasks in which the stimuli either remained stationary, flashed, or moved at systematically varied speeds. Performance was significantly best when the sample stimulus moved quickly and was poorest when the stimuli remained stationary. Further analysis of these data and other previously published data revealed that the distribution of the stimulus movement effect across trials supported an attention allocation interpretation.

2. Smith, J. D., Schull, J., Washburn, D. A., & Shields, W. E. (In press). Uncertainty monitoring in the rhesus monkey (Macaca mulatta). Proceedings of the Congress of the International Primatological Society.

Abstract

We asked whether animals respond adaptively when uncertain, and what cues they monitor in order to do so. Our procedures

offered monkeys two primary discrimination responses, and the opportunity to escape from occasional trials into easier ones. Ideally animals should escape sparingly and only from the difficult trials near their discrimination crossover, and both monkeys did so. Their escapes do not seem to be responses to objective stimuli and situational cues, and a variety of low-level mechanisms fail adequately to capture the phenomenon. In fact, the results encourage the interpretation that monkeys are engaged in a primitive kind of uncertainty monitoring.

3. Washburn, D. (1993). Lateralization of perceptual inspection in joystick-using macaques. American Journal of Primatology. (Abstract only).

#### Abstract

The presentation time required to recognize visual stimuli presented either to the left or right visual field (RVF) were examined using 10 rhesus monkeys and a computerized test system (the LRC-CTS). Each monkey performed 1000 trials of a divided visual field task in which the duration of stimulus presentation was titrated in each hemifield contingent on the accuracy of the previous trial. For example, correctly recognizing a stimulus presented in the RVF caused the presentation duration to be decreased by 16 msec in the next RVF-presentation trial. Additionally, some stimulus presentations were followed by a checkerboard mask. The masking condition was alternated by blocks of trials, whereas visual field was selected randomly each trial. A significant Visual Field X Mask interaction was found; the subjects recognized the form stimuli at significantly briefest presentation durations when presented unmasked to the left visual field. These data, similar to published findings from human and ape subjects, are discussed in light of previous reports of no lateralization of form recognition by rhesus monkeys. (Supported by NASA grant NAG2-438.)

4. Washburn, D, A., Harper, S., & Rumbaugh, D. M. (1993). Computer-task testing in the social milieu. American Journal of Primatology. (Abstract only).

#### Abstract

The effects of single- versus paired-housing were examined using observational data and performance on the computerized test system. Two adult male rhesus monkeys (Abel and Baker) were tested either singly caged or with physical access, via a tunnel, to one another. Behavior was observed and coded in both conditions. The availability of computerized test systems was

also manipulated across housing conditions, and task performance was analyzed as a function of the housing variable. Although the pattern of activity throughout the day differed significantly with access to the test system, no differences were found in task productivity, accuracy, or latency due to housing condition. The monkeys continued to engage the tasks at undisturbed levels even when they had access to one another, and reserved "social behaviors" (e.g., grooming, play) for rest periods. These data suggest that social behaviors, while undeniably important to macaques, are not the quintessence of well-being, but that intellectual challenge, activity, and control are also crucial. (Supported by NASA grant NAG2-438.)

## B. Presentations

1. Washburn, D. A. (1993, August). Lateralization of perceptual inspection in joystick-using macaques. Paper presented at the meeting of the American Society of Primatologists, Sturbridge, MA.
2. Washburn, D. A., Harper, S., & Rumbaugh, D. M. (1993, August). Computer-task testing in the social milieu. Paper presented at the meeting of the American Society of Primatologists, Sturbridge, MA.
3. Washburn, D. A., Astur, R. S., & Raby, P. R. (1993, June). Sources of forgetting in the visuospatial sketchpad of humans and monkeys. Poster presented at the meeting of the American Psychological Society, Chicago, IL.

### Abstract

Humans and monkeys were tested on a computerized task in which forms were recognized following intervals of distractor task or no overt activity. The form of the significant effects suggested that decay and interference, rather than distraction from rehearsal, account for forgetting in the visuospatial sketchpad.

4. Washburn, D. A. (1993, April). Comparative Investigations of Attention. Paper presented at the 85th meeting of the Southern Society for Philosophy and Psychology, New Orleans, LA.

### Abstract

The study of attention across species remains marked by diverse terminology and empirical phenomena. The present investigation was designed to explore the gap between comparative

psychology and the cognitive psychology of attention. Five rhesus monkeys (Macaca mulatta) and 48 human subject volunteers were tested with computerized tasks in two experiments. On each task, the subject manipulated a joystick to respond to computer-generated stimuli in accordance with task demands. To the degree possible, both species were tested under comparable experimental conditions. In the first study, humans and monkeys were able to ignore distracting stimuli in a selective tracking task. However, both species failed to filter irrelevant stimulus features in the second experiment, resulting in Stroop-like effects on a numerosness judgment task. Findings of accurate and comparable selective filtering, as well as parallel disruptions of selectivity in these Stroop-like effects, support the investigation of attention across species. At a time when many interdisciplinary models of cognition are embraced by cognitive science, the utility of comparative models merits reconsideration.

**II. Analysis of QUAL testing:** Three significant test runs were conducted at ARC, and the data were analyzed and reported during this semiannual period. The first test was a qualification run for DBT, ECG, and PTS systems. A preliminary report was provided 1-April-93, with a detailed analysis of the PTS data submitted on 21-July-93. No reliable effects of DBT and ECG implants were reported, and a successful,  $N = 2$ , 20-day test of PTS was described. A second ECG/DBT qualification test, made at ARC in May-June, supported these findings (report provided 2-July-93).

An EMG qualification test was also conducted at ARC and analyzed by Behavior/Performance Project scientists (see report on 2-July-93). These data also revealed a successful PTS test with no overt effects attributable to the EMG implant. As with the DBT/ECG tests, the 20-day run with two monkeys served to identify some small parametric and software problems and issues of concern. These have been addressed in anticipation of future tests.

**III. Critical Design Review:** The Behavior & Performance Project was represented at the Science CDR in June, where we demonstrated the technical feasibility, preliminary results, and statistical analysis plan for our science. We addressed five evaluation criteria:

1. Demonstrate that entire EVT pool can master all 18 behavioral tasks: Complete, as documented in two previous semiannual status reports.
2. Demonstrate that 18 animals from the EVT pool can perform PTS allowing an average food consumption of 600

pellets/day over a 20-day test: Complete; 20-day training data for ARC animals was presented, showing an average of 681 pellets/day.

3. Demonstrate adequacy of Esop hardware design and software: Complete; hardware and software have been used in several successful tests.

4. Provide analyzed PTS baseline data: Complete; preliminary analyses were presented before and at CDR, and a full analysis of the PTS qualification data was provided on 21-July-93.

5. Provide ACUC protocol for training: Complete.

**IV. RESEARCH ACTIVITIES:** The following support studies and research-related activities were undertaken within this semiannual period. Detailed summaries of each study has been provided previously.

**A. Continuation of ongoing studies.** As evidenced by our publications and presentations during this period, we have continued to test 9 GSU animals on a battery of tasks. These sessions contribute to the corpus of normative and support data required for our science. Experiments in visual search, attention scanning, short-term memory, motivation, and psychological well-being are ongoing.

**B. Testing and use of PTS software.** Careful review of PTS software functioning is ongoing. Problems identified within this semiannual period have been communicated to the Software Discrepancy Committee at ARC and have been addressed.

**C. Development of flight schedule of tasks and parameters.** The schedule of tasks projected for the flight, as well as the parametric settings for each task, were modified during this period in accordance with information gleaned during the 20-day qualification tests at ARC. We remain confident that an impressive array of task measures will avail flight data that are sensitive to even subtle alterations in performance and productivity.

**D. Circadian phase-shift study.** In addition to the 20-day tests at ARC, a "flight profile" test was conducted at the Sonny Carter Life Sciences Laboratory to determine the amount of data that might be anticipated by a 14-day preflight / 14-day flight / 14-day postflight experimental design. Additionally, these data provide opportunity to illustrate the statistical analyses we anticipate for flight data. A 4-hour phase shift (light cycle

shifted minus-4 hours) was used instead of flight as the independent variable. Analysis of these data remain preliminary, but suffice at present to support the statistical power of our design and the sensitivity of our measures to alterations caused by such manipulations.